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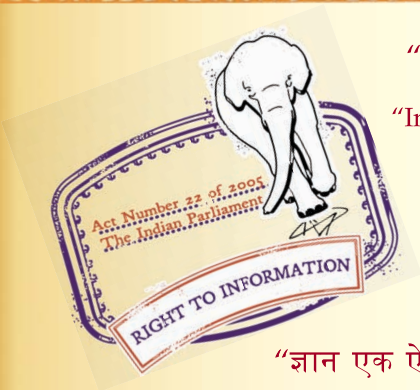
IS 3948 (1986): Specification for Calibrated High Tensile Steel (Round Link) Chain (Electric Butt Welded) for Chain Conveyors and Coal Ploughs Used in Mines [MED 6: Continuous Bulk Conveying, Elevating, Hoisting Aerial Ropeways and Related Equipment]



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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 3948 - 1986

Indian Standard

SPECIFICATION FOR CALIBRATED HIGH TENSILE STEEL (ROUND LINK) CHAIN (ELECTRIC BUTT WELDED) FOR CHAIN CONVEYORS AND COAL PLOUGHS USED IN MINES

(First Revision)

UDC 672·61 : 669·14·018·018·295 : 622·6

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 8 *May* 1987

AMENDMENT NO. 1 NOVEMBER 1988
TO
IS : 3948 - 1986 SPECIFICATION FOR CALIBRATED HIGH TENSILE STEEL (ROUND LINK) CHAIN (ELECTRIC BUTT WELDED) FOR CHAIN CONVEYORS AND COAL PLOUGHS USED IN MINES

(First Revision)

[*Page* 3, *Table* 2, *col.* 10, *second entry*] — Substitute '19.5' *for* '17.5'.

(EDC 61)

Printed at Swatantra Bharat Press, Delhi, India

Indian Standard

SPECIFICATION FOR CALIBRATED HIGH TENSILE STEEL (ROUND LINK) CHAIN (ELECTRIC BUTT WELDED) FOR CHAIN CONVEYORS AND COAL PLOUGHS USED IN MINES

(First Revision)

Conveyors, Vertical Hoists and Bucket Elevators Sectional Committee, EDC 61; Chain and Rope Conveyors Subcommittee, EDC 61 : 2 [Ref : Doc : EDC 61 (3386)]

1. Scope — Covers the requirements for high grade special purpose calibrated high tensile electric butt welded steel chain (round link) for use with machines and equipments in mining, such as:

a) Conveyors, flexible and rigid of the chain type, chain belt conveyors, gate end and stage loaders;

b) Coal ploughs, coal cutters and power loaders;

c) Bucket elevators; and

d) Other similar machines used in mines.

1.1 Chains for lifting purposes in mines are not covered by this standard.

2. Terminology — The following definitions shall apply for the purpose of this standard.

2.1 *Chain Size (Nominal Diameter)* — The diameter used for designating the chain.

2.2 *Material Diameter* — Diameter of the material in the chain link as measured.

2.3 *Pitch of Chain* — Internal length of a link.

2.4 *Proof Force* — Force to which, after processing, the whole of the chain is subjected as specified.

2.4.1 This force may be reapplied to the whole of the new chain or to any part thereof by the purchaser and/or his inspector at their discretion.

2.5 *Test Force* — The specified force to which a sample of the finished chain has to be subjected without exceeding the stated elongation.

2.6 *Processing* — Any treatment of the chain subsequent to welding, for example, heat treatment, polishing or calibrating.

2.7 *Competent Person* — The person who is approved and declared as such under the relevant statutory or other provisions.

2.8 *Breaking Force (Ultimate)* — The maximum force which a sample of finished chain withstands during the course of a tensile test to destruction.

2.9 *Inspector* — The representative of the purchaser or of the statutory or other authority, authorized to inspect the chains.

2.10 *Percentage Elongation* — The extension expressed as a percentage of the gauge length.

2.11 *Calibration* — The application of force to the whole of the chain during the production process to control the link dimensions.

2.12 *Setting Force* — The force applied to hold the sample under tension while the gauge length is marked and/or the extensometer is fitted.

3. Grades and Mechanical Requirements of Chain — Chains classified into three grades, namely, Grade B, C and D shall have mechanical properties as specified in Table 1.

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TABLE 1 BASIC REQUIREMENTS OF CHAINS OF VARIOUS GRADES
(*Clauses* 3, 8.6.1 *and* 8.6.3)

Characteristic	Grade		
	B	C	D
Minimum breaking stress in N/mm²	630	800	1 000
Stress at test force in N/mm²	500	640	800
Total maximum elongation under test force, percent	1·4	1·6	1·9
Minimum ultimate total elongation at fracture (UTE), percent	12	12*	12*
Ratio : $\frac{\text{Test force}}{\text{Minimum breaking force}} \times 100$	80	80†	80†

*In view of the difficulty which may be faced by the industry to come up to the standard value of UTE, the value of 10 may be accepted for Grades C and D for the time being.

†If agreed to between the purchaser and the manufacturer, the ratio of test force to minimum breaking force for Grades C and D quality chains of 26 and 30 mm sizes may be reduced from 80 to 70 percent.

4. Dimensions — The nominal sizes and dimensions of the chain shall be as given in Table 2 read with Fig. 1 and 2.

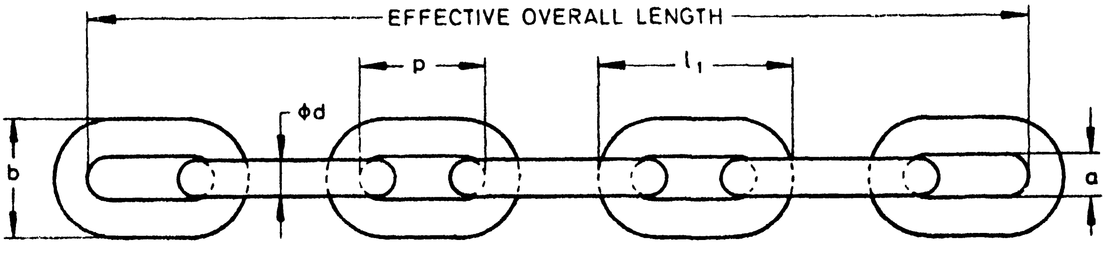


FIG. 1 DIMENSIONS FOR STEEL CHAIN (ROUND LINK)

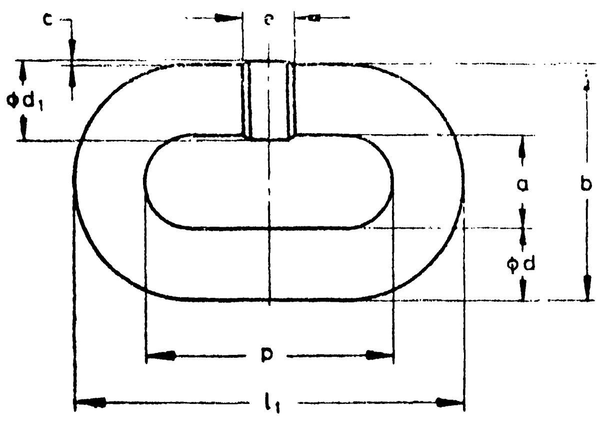


FIG. 2 DIMENSIONS FOR CHAIN LINK

TABLE 2 CHAIN LINK DIMENSIONS AND MASS FOR SYMMETRICALLY WELDED CHAIN

(*Clause* 4; and *Fig.* 1 *and* 2)

All dimensions in millimetres.

Diameter of Material in the Finished Link		Pitch p		Width		Length l_1		Weld			
Chain Size d	Tolerance	Nominal	Tolerance	Inside *Min* a	Outside *Max* b	Nominal	Tolerance	Allowable offset *Max* c	Diameter *Max* d_1	Length *Min* e	Mass per metre, approx kg/m
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
14	±0·4	50	±0·5	17	48	78	+0·5 −1·3	0·4	15	10	4·0
18	±0·5	64	±0·6	21	60	100	+0·6 −1·6	0·5	17·5	13	6·6
22	±0·7	86	±0·9	26	74	130	+0·9 −2·3	0·7	23·5	15·5	9·5
24	±0·8	86	±0·9	28	79	134	+0·9 −2·5	0·7	26	17	11·6
26	±0·8	92	±0·9	30	86	144	+0·9 −2·5	0·8	28	18	13·7
30	±0·9	108	±1·0	34	98	168	+1·0 −2·8	0·9	32·5	21	18·0

4.1 *Material Diameter*

4.1.1 *Diameter of material in the link* — The nominal diameter of the material in the link except at the weld shall be as stated in col 1 of Table 2 subject to the tolerances specified in col 2 of Table 2.

4.1.1.1 The tolerance on the diameter of the material in the link shall be applied to the average of two readings taken at a right angle in the same section.

4.1.1.2 The measurement of diameter may alternatively be done as per the procedure given in Appendix A of IS : 5616-1982 'Specification for short link chain, for lifting purposes: General conditions of acceptance (*first revision*)'.

4.1.2 *Diameter of steel at the weld* — The diameter of the steel at the weld d_1 shall not be less than the actual diameter of the steel adjacent to the weld nor shall it exceed the diameter stated in col 10 of Table 2.

4.1.2.1 The weld offset *c* shall not exceed the actual diameter of the steel by more than the value stated in col 9 of Table 2 and shall not be below the surface of the parent material.

4.1.3 *Position and extent of weld* — The welds shall be positioned in the centre of one leg of the link of the chain. The area affected by the welding shall not be more than the value specified in col 11 of Table 2.

4.2 *Pitch* — The pitch of the link of the chain shall be as given in col 3 of Table 2 subject to the tolerance as specified in col 4 of Table 2.

4.3 *Width of the Link* — The minimum inside width *a* and the maximum outside width *b* of the link, except at the weld, shall be as given in col 5 and 6 respectively of Table 2.

4.4 *Length*

4.4.1 *Nominal outside length of link* — The nominal outside length of the links (*see* Fig. 1) shall be as stated in col 7 of Table 2 subject to a tolerance as specified in col 8 of Table 2. This is theoretical length of link and may be lesser than the stated overall length due to flatening during manufacture.

4.4.2 *Nominal multiple pitch length* — The nominal multiple pitch length (*see* Fig. 1) that is the nominal pitch of link multiplied by the number of links specified shall be in accordance with the order. The number of links per length shall be an odd number.

4.4.3 *Tolerance on actual multiple pitch length* — The actual multiple pitch length of the chain measured in finished condition and under setting force as specified in Table 6 shall not vary from the nominal multiple pitch length by more than

$$\pm \frac{p}{100} (1 + 0{\cdot}15\,N)$$

where

p = the nominal pitch, and

N = the specified number of links.

4.4.3.1 Where N is 1, the tolerance shall be rounded down to 1 percent.

4.4.3.2 The nominal multiple pitch lengths and their tolerances are given in Table 3.

4.5 *Matching of Length* — Where the chain is required in short lengths of a specified number of links for use in double or triple chain conveyors they shall be so mentioned in the order and supplied in matched lengths. The length measured under setting force as specified in Table 6 shall not vary from one chain of the matched set to another by more than the following:

For Lengths	*Variation Allowed*
Up to and including 2 m	0·10 percent of total length
More than 2 m	0·15 percent of total length

Note — It is recommended that for lengths less than 1 m, the variation in length shall not exceed 1 mm.

TABLE 3 MULTIPLE PITCH LENGTHS

(*Clause* 4.4.3.2)

All dimensions in millimetres.

Chain Size and Pitch	Multiples of Pitch									
	3	5	7	9	11	13	15	17	19	21
14×50	150 ±0·7	250 ±0·9	350 ±1·0	450 ±1·2	550 ±1·3	650 ±1·5	750 ±1·5	850 ±1·8	950 ±1·9	1050 ±2·1
18×64	192 ±0·9	320 ±1·1	448 ±1·3	576 ±1·5	704 ±1·7	832 ±1·9	960 ±2·1	1088 ±2·3	1216 ±2·5	1344 ±2·7
22×86	258 ±1.2	430 ±1·5	602 ±1·8	774 ±2·0	946 ±2·3	1118 ±2·5	1290 ±2·8	1462 ±3·1	1634 ±3·3	1806 ±3·6
24×86	258 ±1·2	430 ±1·5	602 ±1·8	774 ±2·0	946 ±2·3	1118 ±2·5	1290 ±2·8	1462 ±3·1	1634 ±3·3	1806 ±3·6
26×92	276 ±1·3	460 ±1·6	644 ±1·9	828 ±2·2	1012 ±2·4	1196 ±2·7	1380 ±3·0	1564 ±3·3	1748 ±3·6	1932 ±3·8
30×108	324 ±1·6	540 ±1·9	756 ±2·2	972 ±2·5	1188 ±2·9	1404 ±3·2	1620 ±3·5	1836 ±3·8	2052 ±4·2	2268 ±4·5

4.5.1 If agreed to between the purchaser and the manufacturer chains with other matching tolerances may be supplied. An example of tighter matching tolerances is given in Appendix A.

4.6 *Mass* — The mass of a single chain per metre length shall be approximately as given in col 12 of Table 2.

4.7 The nominal sizes and dimensions of cylindrical welded and assymetrical welded chains are given in Appendix F only (*also see* Fig. 10).

5. Material

5.1 The chain shall be made from steel which in its finished state as used by the chain manufacturer, shall meet the following requirements:

a) The steel shall be fully killed and shall posses reliable welding quality.

b) The content of sulphur and phosphorus shall be as shown in Table 4.

TABLE 4 CONTENT OF SULPHUR AND PHOSPHORUS

Element	Cast Analysis, Percent		Check Analysis, Percent	
	Grade *B*	Grade C and D	Grade B	Grade C and D
Sulphur, *Max*	0·040	0·030	0·040	0·035
Phosphorus, *Max*	0·035	0·030	0·040	0·030

c) The steel shall be of such composition as to guarantee the mechanical properties of the chain after appropriate heat treatment. For grades C and D an alloy steel containing alloy in elements such as nickel, chromium, molybdenum manganese more than one percent shall be used. Care shall be exercised in the choice of steel so that the achievement of high ultimate tensile stress in the material does not result in the disproportionate loss of other properties, particularly notch toughness.

d) The steel shall be made in conformity with fine grain practice to give an austenitic grain size of 5 or finer when tested in accordance with the standard. This could be accomplished, for example, by ensuring that it contains sufficient aluminium of equivalent element to allow the manufacture of chain stabilized against strain age embrittlement during service; a minimum value of 0·020 percent metallic aluminium is quoted for guidance, and to safeguard weldability, a maximum of 0·055 percent.

5.2 The steel which meets these requirements and when suitably heat-treated in the form of the finished chain meets the specific requirements with regard to the mechanical properties, may be used.

5.3 The steel wire, rod or bar used for the links shall be cleanly finished and shall be free from harmful flaws and surface defects. If required by the purchaser, the following information shall be supplied:

a) The method of steel manufacture and the steel-maker's cast analysis;

b) An analysis of steel millings taken from, and representative of, a link which formed part of a length tested to destruction.

6. General Requirements

6.1 *Workmanship* — The fins caused by welding shall be removed and welds shall be smoothly finished. Any links which, on visual examination, show deterimental fissures, notches or similar faults shall be rejected.

6.2 *Insertion of Links* — Links which have been inserted shall be processed and inspected so as to ensure that every link in the chain is in uniform condition.

6.3 *Surface Finish/Coating* — Unless otherwise agreed to between the purchaser and the manufacturer, the chains after inspection and testing, shall be supplied with any of the following finish/coating:

a) Rust-preventive coating;
b) Polished finish with oilings;
c) Coloured coating; and
d) Rumbling without abrasives and oiled.

6.4 *Colour Coding* — Chains of different grades shall be colour coded with the following colours:

Grade	*Colour*
B	Green
C	Red
D	Yellow

7. Heat Treatment — All chains shall, before proof testing, be subjected to a suitable heat treatment. While the precise heat treatment procedure shall be manufacturer's responsibility, the following conditions shall, however, be observed:

a) The heat treatment shall not produce brittleness in the chain; and
b) Heating to a temperature within 50 degree above the upper critical point (AC_3) of the steel used, forms part of the heat treatment.

8. Tests

8.1 *Type Tests* — Tests specified in **8.4, 8.5, 8.6, 8.7, 8.8** and **8.9** shall constitute type tests and shall be carried out on samples selected in accordance with **8.3**.

8.2 *Routine Tests* — Tests specified in **8.4, 8.5** and **8.6** shall constitute routine tests and shall be conducted on samples selected in accordance with **8.3**.

8.2.1 If agreed to between the purchaser and the manufacturer, tests specified in **8.7**, **8.8** and **8.9** may also be conducted as routine tests.

8.3 *Selection of Samples* — Unless otherwise specified by the purchaser, the sampling arrangements given below shall apply. This shall not preclude the inspector from asking for such further samples as he may deem necessary:

a) Test samples shall be selected at random, the chains shall be in the same condition as the bulk of the chain and shall be free from any coating which might obscure defects;

b) For sampling purposes, the chains shall be divided into lots consisting of 200 metres and part thereof of chains of 200 lengths and part thereof of chains of one metre or less each;

c) For the chains supplied in long lengths, the samples shall be taken from each end of the finished chain. If considered necessary by the inspector the samples may be taken from any point along the length of the chain if specified in accordance with 12 (g) at the time of enquiry or order;

d) Dimensional tests — 5 individual links shall be taken at random from each lot of finished chain;

e) Static tensile test — 2 samples shall be taken from each lot of finished chains. For 14 mm chains each sample shall contain 7 links and for chains of 18 mm and above each sample shall contain 5 links;

f) Bend test — A single link sample shall be taken from each lot;

g) Fatigue test — One sample of three links shall be taken from 5 lots of order if the order is less than 5 lots; and

h) Notch impact test — 3 single links shall be taken from 5 lots or order if the order is less than 5 lots.

8.3.1 The samples shall be selected in such a manner so as to affect the least number of chains for reprocessing. This may be achieved by taking random pair(s) for selecting all the test samples.

8.4 *Proof Force Test* — After heat treatment and other processing(s), the finished chain shall be subjected to a proof force of at least 90 percent of the test force specified in Table 6, in a testing machine conforming to the requirements specified in Appendix B. Care shall be taken to ensure that the chain is placed in the testing machine without twist. After removal of the force, the chains shall be subjected to a thorough visual examination by a competent person and any fractured or defective links shall be replaced. If this requirement is met during the calibration process then no separate proof force testing is necessary.

8.4.1 The portion of the chain affected by any inserted link (inserted either during the course of manufacture or due to replacement as specified in **8.4**) shall be again subjected to proof force and re-examined.

8.5 *Dimensional Tests* — The dimension of the link shall be gauged and checked for conformity to the requirements of **4** when chain is held in vertical position.

8.6 *Static Tensile Tests* — The samples selected shall be subjected to static tensile tests in a testing machine conforming to the requirements given in Appendix B and the elongation under test force, breaking force (ultimate) and the ultimate extension shall be determined.

8.6.1 *Elongation under test force* — The sample shall be inserted into the grips of the machine and shall be subjected to a force not exceeding half of the test force (*see* Table 5). The force shall then be decreased to the corresponding setting force (*see* Table 6). With the sample held under this tensioning force, the appropriate gauge length shall be marked and the extensometer, if used, shall be attached to the sample gauge length marking shall be as near to the centre of link as possible on both the marked links. The force shall then be raised gradually till the test force specified in Table 5 is reached. The extension shall be measured when the specified test force has been reached. The percentage total elongation shall be determined by dividing measured elongation by the gauge length and multiplying by 100. This percentage total elongation shall not exceed the values given in Table 1 for the particular grade of chains.

8.6.2 *Ultimate breaking load* — After the test force has been applied and elongation measured as required in **8.6.1** the extensometer if attached shall be removed and the test force shall be increased till the sample breaks. The breaking force (ultimate) thus determined shall be not less than that specified in Table 5 for the particular grade of chain.

TABLE 5 REQUIREMENTS OF CHAINS
(*Clauses* 8.4, 8.6.1 *and* 8.6.2)

Chain Size and Pitch	Grade B		Grade C		Grade D	
	Minimum Breaking Force	Test Force	Minimum Breaking Force	Test Force	Minimum Breaking Force	Test Force
mm	kN	kN	kN	kN	kN	kN
14×50	190	150	250	200	310	250
18×64	320	250	410	330	510	410
22×86	480	380	610	490	760	610
24×86	570	450	720	580	900	720
26×92	670	530	850	680	1060	850
30×108	890	710	1130	900	1410	1130

8.6.3 *Ultimate total elongation at fracture* — From the force extension diagram derived during the test, the ultimate total elongation of the sample shall be determined. The percentage minimum ultimate total elongation at fracture, determined by dividing the ultimate total elongation of sample by the nominal multiple pitch length of the sample and multiplying by 100, shall not be less than the values specified in Table 1 for the particular grade of chain.

8.7 *Fatigue Test* (*Optional*) — The samples selected shall be subjected to a frequency of force application of not less than 200 cycles/minute and not greater than 1 000 cycles/minute between upper and lower test force limits specified in Table 7 corresponding to stress levels specified in Table 8 at a temperature not exceeding 50°C. The total number of cycles withstood by sample shall be not less than 30 000. In case the frequency of force application is not a matter of agreement between the purchaser and the manufacturer (within the range of 200 to 1 000 cycles/minute), the test shall be conducted at 500 cycles/minute.

8.7.1 The testing machine used for conducting the fatigue test shall be suitable for applying forces specified in Table 7 and shall be calibrated statically in accordance with Class 1 of IS : 1828-1975 'Method for load verifications of tensile testing machines (*first revision*)', and shall be checked occasionally by some electrical measuring devices that can be mounted on the machine in series with the sample. The chain anchorage of the machine shall comprise an anchorage fork as shown in Fig. 3 and an anchorage pin as shown in Table 9. Machine anchorage shown in Fig. 3 is not standardized and shown for illustration only.

8.7.2 If agreed to between the purchaser and the manufacturer the acceptance level for fatigue resistance may be determined statistically as given in Appendix C.

8.8 *Bend Test* — Samples selected in accordance with 8.3(f) shall withstand without fracture the minimum deflection specified in Table 10 when subjected to a bend test in a shock free manner as shown in Fig. 4.

8.9 *Notch Impact Test* — This test is optional and is intended for investigation into the steel used for chain making and shall be conducted as specified in Appendix D.

9. Criteria for Acceptance — A lot shall be deemed to comply with this standard if each of the samples taken from the lot fulfills the specifed test requirements.

9.1 In case the sample fails in any of the test requirements two further samples shall be selected from the same lot and subjected to the same test, if both the additional tests are satisfactory the lot shall be deemed to comply with this standard.

10. Inspection, Certificate of Test and Examination

10.1 The inspcetor shall have access to the works of the manufacturer at all reasonable times for the purpose of witnessing the specified tests and inspecting the testing machine and methods of examination.

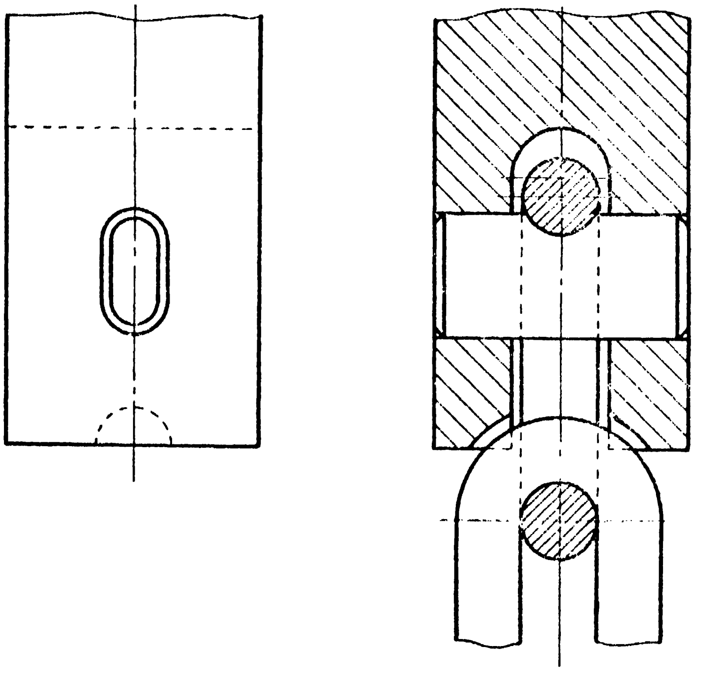


FIG. 3 ANCHORAGE FORK ARRANGEMENT

TABLE 6 GAUGE LENGTH AND SETTING FORCE
(*Clause* 8.6.1)

Chain Size and Pitch mm	Gauge Length mm	Setting Force kN
14×50	200	8
18×64	256	13
22×86	344	19
24×86	344	23
26×92	368	26
30×108	432	35

10.2 The manufacturer shall supply a certificate of test and examination with every supply of the chains. The certificate shall give the results of tests made and shall be signed by the manufacturer and by the inspector, who witnessed the acceptance test.

11. Marking

11.1 *Identification Marking* — Marks identifying the manufacturer, the period of production and the grade shall be legibly stamped in the following manner:

a) Chain up to and including two metres in length — At least one mark, the mark(s) shall be at the end(s) of the chain, and

b) Chain greater than two metres in length — One mark near each end and one or more marks along the chain such that the distance between any two marks does not exceed ten metres.

TABLE 7 FATIGUE TEST — LOWER AND UPPER FORCE LEVELS
(*Clauses* 8.7 *and* 8.7.1)

Chain Size and Pitch mm	Grade B		Grade C		Grade D	
	Lower kN	Upper kN	Lower kN	Upper kN	Lower kN	Upper kN
14 × 50	15	77	15	102	15	123
18 × 64	25	127	25	168	25	204
22 × 86	38	190	38	251	38	304
24 × 86	45	226	45	299	45	362
26 × 92	53	265	53	350	53	425
30 × 108	71	353	71	467	71	566

TABLE 8 FATIGUE TEST — LOWER AND UPPER STRESS LEVELS
(APPROXIMATE)
(*Clause* 8.7)

Grade B N/mm²		Grade C N/mm²		Grade D N/mm²	
Lower	Upper	Lower	Upper	Lower	Upper
50	250	50	330	50	400

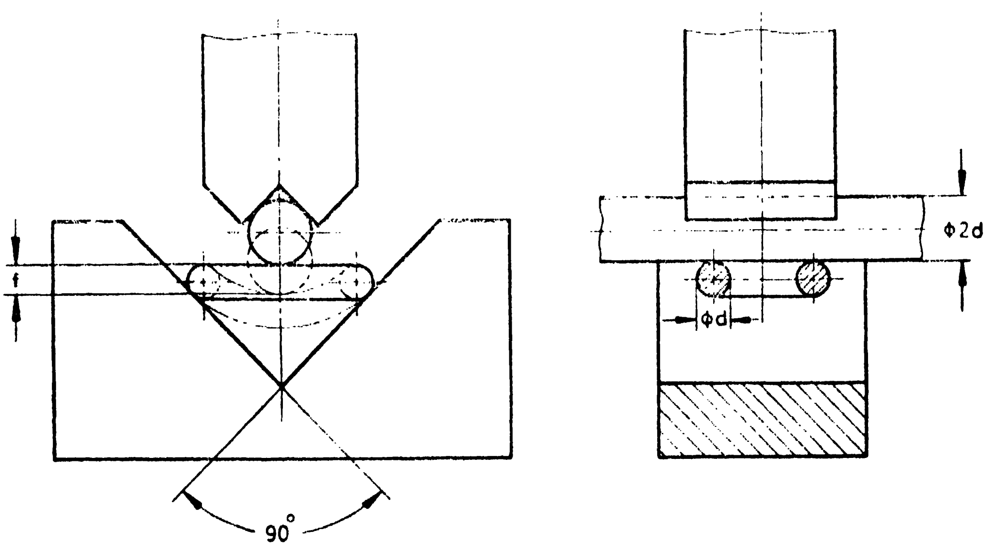


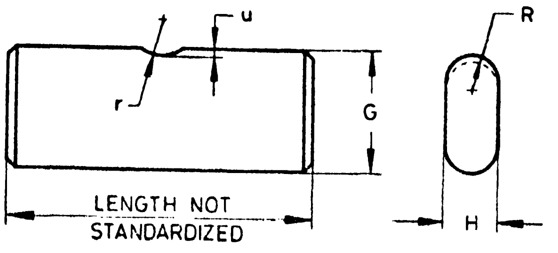
FIG. 4 BEND TEST ARRANGEMENT

11.1.1 Marking shall be on the straight side of the link and in no case shall coincide with the weld. The marking shall be neat, even and shall neither be too sharp or of excessive depth. The details of the identification marking are given in Appendix E.

11.2 *Inspection Marking* — When the test results are satisfactory the inspector shall stamp, with a distinguishing mark, all end links of the chain from which the samples have been taken, at a position not coinciding with the weld. The marking shall be neat, even and shall neither be too sharp nor of excessive depth.

11.3 *Certification Marking* — Details available with the Bureau of Indian Standards.

TABLE 9 FATIGUE TEST – ANCHORAGE PIN DIMENSIONS
(*Clause* 8.7.1)



All dimensions in millimetres.

Chain Size and Pitch	*G* 0 −0·1	*H* ±0·2	*R*	*r*	*u*
14×50	30	14	7	9	1
18×64	40	18	9	11	1
22×86	50	22	11	13	2
24×86	50	24	12	14	2
26×92	55	26	13	16	2
30×108	60	30	15	18	2

TABLE 10 BEND TEST – DEFLECTION
(*Clause* 8.8; and *Fig* 4)
All dimensions in millimetres.

Chain Size and Pitch	Deflection, *f*, *Min*
14×50	11
18×64	14
22×86	18
24×86	20
26×92	21
30×108	24

12. Information to be Supplied at the Time of Enquiry or Order — The purchaser shall specify the following in his enquiry or order:

a) Grade of chain;

b) Size of chain in mm;

c) Pitch of chain in mm;

d) Surface finish/coating in which it is to be supplied (*see* **6.3**);

e) Whether the chain is to be supplied in:

1) short lengths (state the number of links which shall be an odd number) and multiple pitch length, or

2) exact continuous long length (state overall length), or

3) random lengths (state minimum overall length acceptable);

f) If the information regarding material is required;

g) If special sampling arrangement is required [*see* **8.3**(c)];

h) If fatigue test is required, if so, method of test analysis (*see* **8.1** and **8.7**);

j) If information regarding bend test is required (*see* **8.8**);

k) If notch impact test is required (*see* **8.9**);

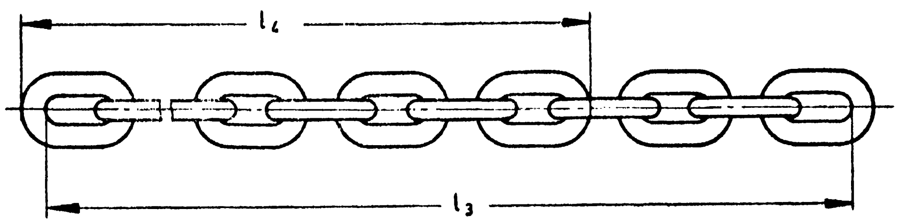
m) If any special marking is required (*see also* **11**); and

n) If colour coding is required (*see* **6.4**).

APPENDIX A

(*Clause* 4.5.1)

TYPICAL EXAMPLES OF MATCHING TOLERANCES FOR MATCHED LENGTHS OF LONG CHAINS



All dimensions in millimetres.

Chain Size and Pitch	Number of Links	Length l_3		Length l_4		Number of Measurements
		Nominal	Tolerance*	Nominal	Tolerance	
22×86	23 35 47 59	1 978 3 010 4 042 5 074	$^{+2}_{0}$	989 (11 links)	+1·5	2 3 4 5
	119	10 2[illegible]4	$^{+3}_{0}$			10
	239	20 554	$^{+6}_{0}$			20
	299	25 714	$^{+8}_{0}$			25
26×92	19 29 39 49	1 748 2 668 3 588 4 508	$^{+2}_{0}$	879 (9 links)	+1·5	2 3 4 5
	99	9 108	$^{+3}_{0}$			11
	199	18 308	$^{+6}_{0}$			22
	249	22 908	$^{+8}_{0}$			27
30×108	19 29 39 49	2 052 3 132 4 212 5 292	$^{+2}_{0}$	1 031 (9 links)	+1·5	2 3 4 5
	99	10 692	$^{+3}_{0}$			11
	199	21 492	$^{+8}_{0}$			22

*When subjected to the setting force stated in Table 2.

APPENDIX B

(*Clauses* 8.4 *and* 8.6)

REQUIREMENTS OF CHAIN TESTING MACHINES

B-1. The testing machine shall not proof force more than 30 m in one test and shall have an accuracy Class 1 according to IS : 1828-1975.

B-2. The straining mechanism of the proof testing machine shall be sufficiently long to allow a chain of full length of the testing bed to be subjected to the proof force without the necessity for taking a fresh hold to complete the strain.

B-3. The machine shall be accurate enough to take measurements within a tolerance of $\pm$ 5 percent of the proof force applied.

B-4. Machines measuring the force by levers and weights or by pendulum shall be verified and adjusted, as necessary, by a competent and independent person/agency at intervals not greater than one year. For machines measuring the force other than by levers and weights or by pendulum, the interval shall be not greater than three months. The testing machine shall be balanced in the presence of the inspector before the tests are made.

B-5. The testing machine shall be equipped with an autographic recorder which permits a load extension diagram to be derived during the test (*see* Fig. 5). The diagram produced on the machine shall show the relative movements between the machine crossheads.

B-6. A signed certificate of the last examination shall be prominently displayed adjacent to the machine.

B-7. Adequate facilities shall be provided, with a suitable lighting, for the purpose of examining the chains after they are proof tested.

B-8. Chain Anchorages — The testing machine shall have chain anchorages as shown in Fig. 6.

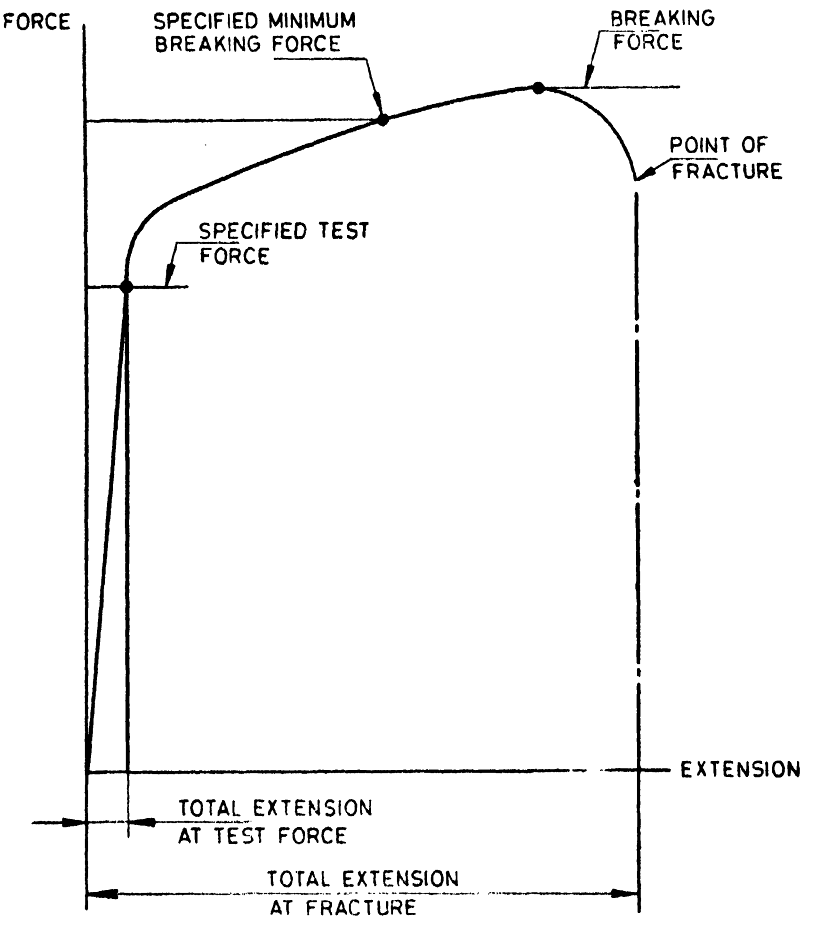
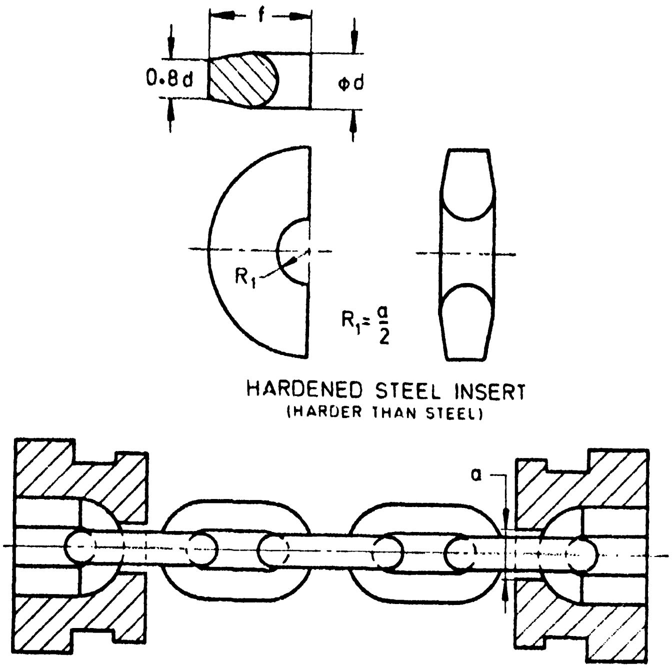


FIG. 5 FORCE EXTENSION DIAGRAM (ILLUSTRATION OF TERMS)



d = Nominal dia of chain material
f = Depends on anchorage

Note 1 — Clearance shall be provided for extensometer mounting.
Note 2 — Half a chain link may be used as an alternative to the hardened steel insert.

FIG. 6 CHAIN ANCHORAGE FOR STATIC TENSILE TEST

APPENDIX C

(*Clause* 8.7.2)

FATIGUE TEST — STATISTICAL ANALYSIS

C-1. If more information about fatigue resistance (or endurance) is required than is outlined in **8.7**, the purchaser and the manufacturer may agree acceptance criteria by a statistical method, provided that such agreement is made at the time of order. Since fatigue tests give relatively scattered values, it may be necessary to take a greater number of samples and to adopt a statistical analysis procedure.

C-2. A convenient method of analysing the results is to plot them on a diagram with:

a) on one scale — the number t of cycles to fracture (endurance) of the individual samples (logarithmic scale);

b) on the other scale — the probability of fracture of the samples, that is, the percentage of samples having an endurance less than t (gaussian cumulative scale).

C-3. An example of plotting this diagram is illustrated as follows (*see* Fig. 7):

a) the numbers of cycles are ranked and plotted on the ordinate; and

b) the probability of fracture is plotted on the abscissa, using the formula:

$$\frac{r - 0.3}{n + 0.4}$$

where

r = ranked value; and
n = total number of tests.

C-3.1 Figure 7 illustrates the plotting of diagram with following data/calculations:

Cycles to Fracture t	Rank r	Plotting Points $\frac{i - 0.3}{n + 0.4} \times 100$
34 480	1	6·7
41 730	2	16·4
48 010	3	26·0
49 500	4	35 6
53 600	5	45·2
55 430	6	54·8
58 200	7	64·4
63 440	8	74·0
65 380	9	83·7
68 470	10	93·3

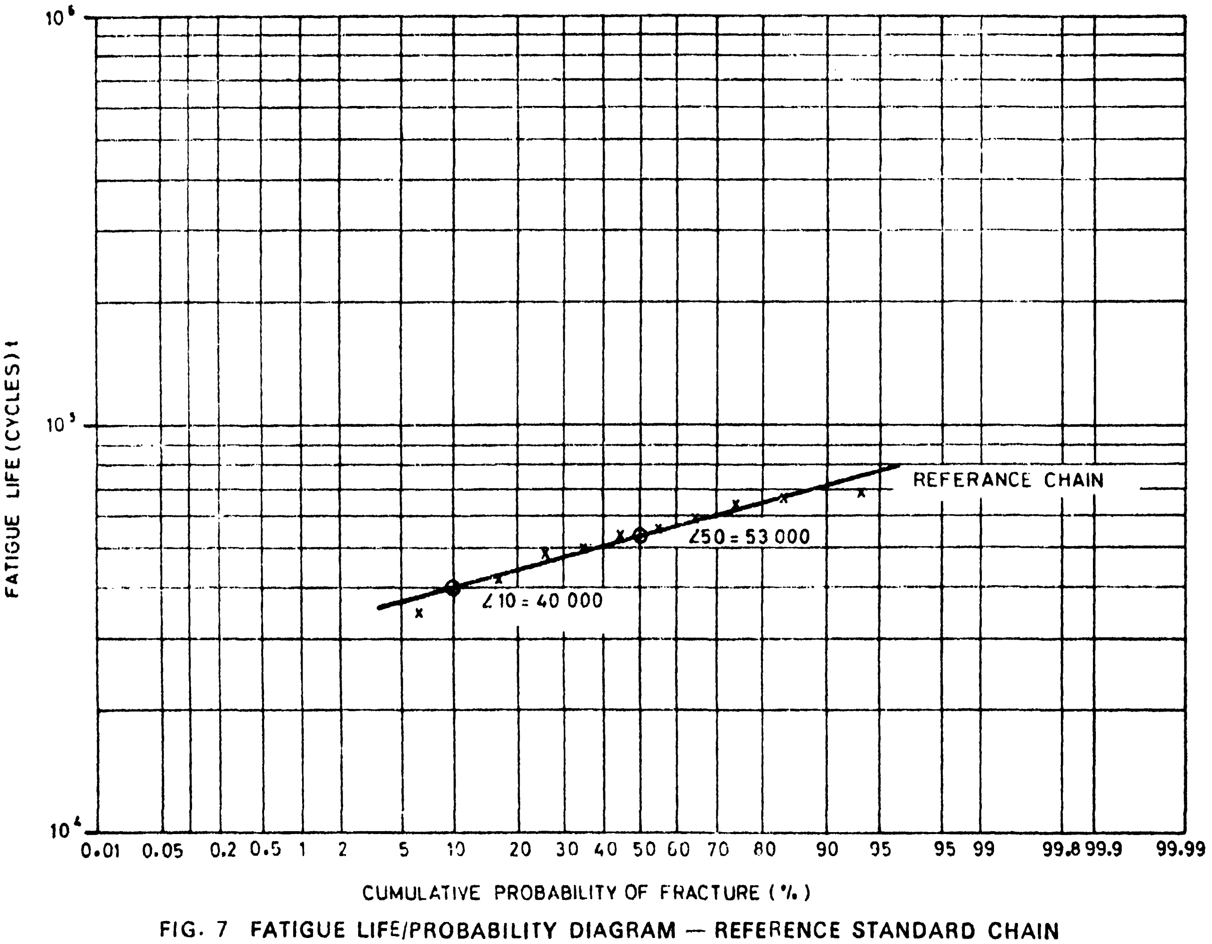


FIG. 7 FATIGUE LIFE/PROBABILITY DIAGRAM — REFERENCE STANDARD CHAIN

C-4. A straight line is then fitted to the points, and the values for say L 10 and L 50 are obtained from the line, where L 10 is the average life at which 10 percent of the samples will have fractured, and L 50 is the average life at which 50 percent of the samples will have fractured.

C-5. The slope of the line is a measure of the dispersion of the results, a horizontal line indicating zero dispersion.

C-6. The acceptance criterion is based on a comparison of the test results with data obtained from a 'reference' chain which has been thoroughly investigated.

C-7. Information shall be supplied by the purchaser to indicate the appropriate lines and the dispersion of the results for the reference chain. An example of a reference chain is shown in Fig. 7,

C-8. The method described in Fig. 7 is only an example, and other methods of graphical representation and acceptance criteria could be used by agreement between the purchaser and the manufacturer.

APPENDIX D

(*Clause* 8.9)

NOTCH IMPACT TEST

D-1. Notch impact test is an optional test for assessing the notch ductility of the steel from machined samples which are taken from the core of the straight legs of each sample link. Additionally, it is a means for comparing the notch ductility of the steel in the welded side with the unwelded side of the chain link, where applicable.

D-2. Preparation of Test Pieces — Two notch impact test pieces shall be prepared from each of the straight legs of the sample links as shown in Fig. 8. In case of a notch impact test piece from the welded side of the chain link, the axis of the notch shall coincide with the actual weld line, the latter having been made visible by means of etching with acid. The test pieces shall be machined to the dimensions and surface finish as given in Fig. 9.

D-3. Testing — Notch impact tests shall be carried out in a charpy pendulum machine, the test piece being positioned symmetrically on two supports at a distance of 40 mm apart, and the ambient temperature being 20°C.

D-4. Test Results — The minimum charpy value for the notch in weld for grades B and C shall be not less than 300 kJ/m². Value for Grade D shall be the subject of agreement between the purchaser and the manufacturer.

D-5. Analysis of Results — Notch impact tests are prone to considerable scatter in the results and may require detailed technical interpretation.

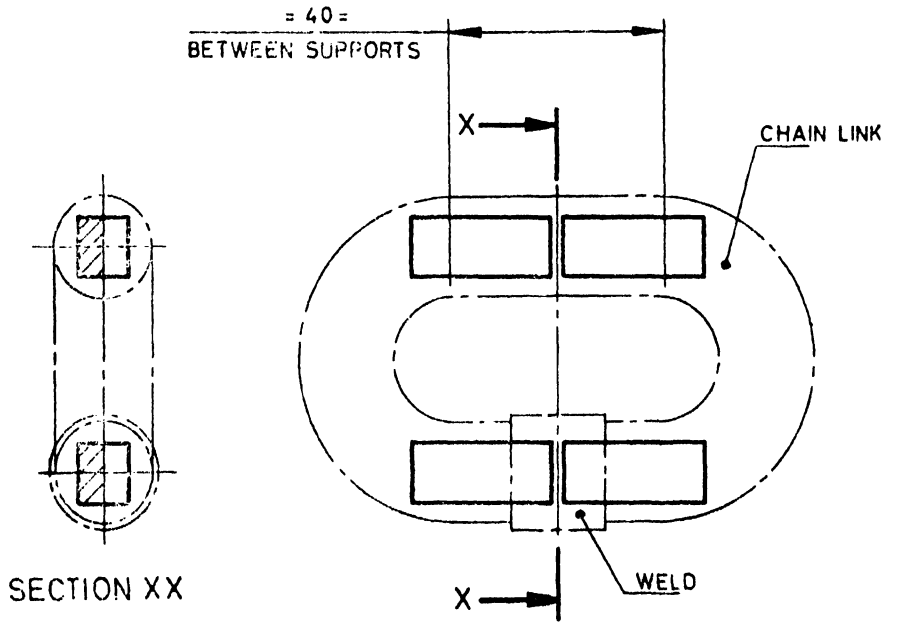
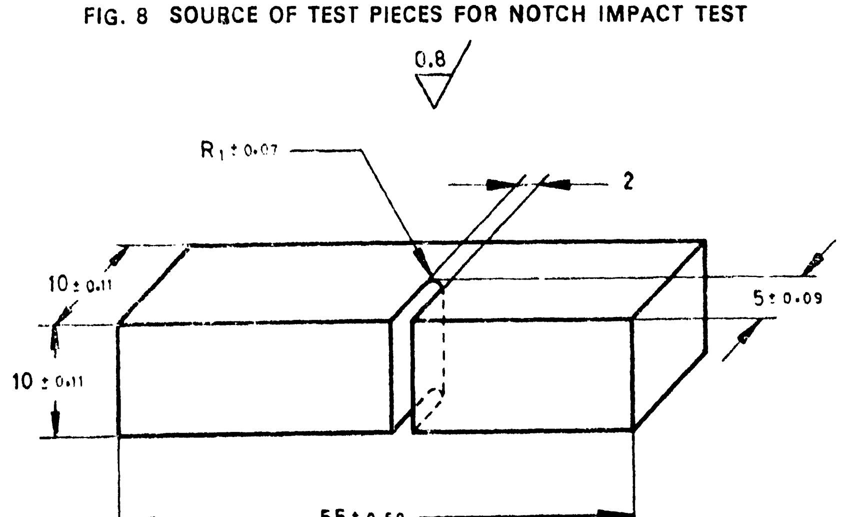


FIG. 8 SOURCE OF TEST PIECES FOR NOTCH IMPACT TEST



All dimensions in millimetres.

FIG. 9 DIMENSIONS OF TEST PIECE FOR NOTCH IMPACT TEST

APPENDIX E

(*Clause* 11.1.1)

IDENTIFICATION CODE

E-1. The identification code shall include the following marks in the given order:

a) Manufacturer's symbol (single mark only);

b) Numbers denoting the date of production, consisting of last digit of year and the number of the month; and

c) Letter denoting grade of chain.

E-2. An example of the code is 'N611C' for a grade C chain made by the 'N' manufacturing company in November 1986.

E-3. Manufacturer shall avoid selection of the letters 'B', 'C' or 'D' as their symbol, as these may be confused with the grade of the chain.

E-4. The numbers denoting the month and year of manufacture may, at the option of the purchaser, be replaced by symbols to indicate such other information as may be required from the manufacturer.

E-5. Size of marking (diameter of mark) shall be less than 4·5 mm.

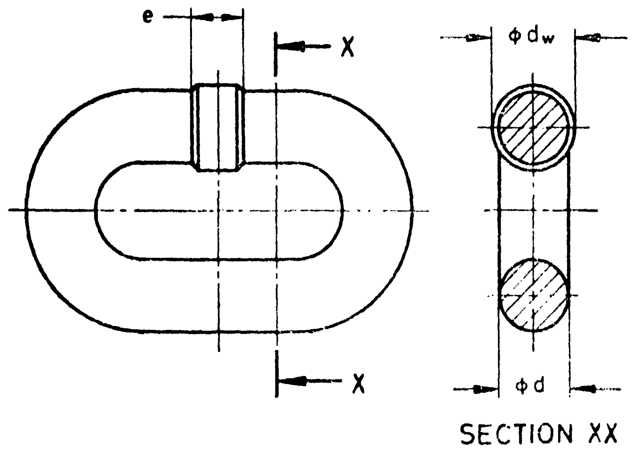
APPENDIX F

(*Clause* 4.7)

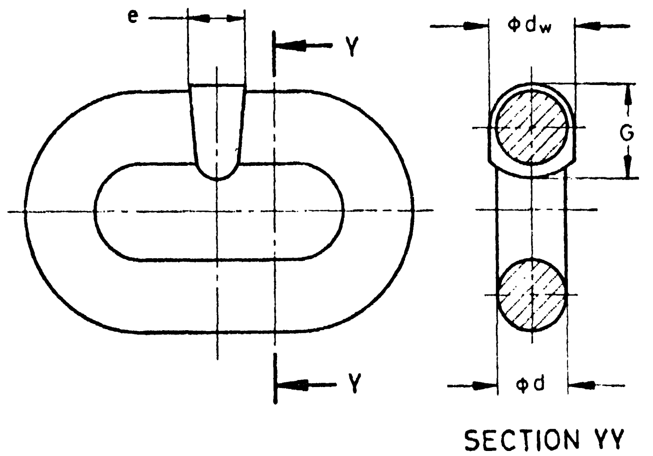
NOMINAL SIZES AND DIMENSIONS OF CYLINDRICAL WELDED AND ASSYMETRICAL WELDED CHAIN LINKS

All dimensions in millimetres.

Nominal Size	Allowable Weld of Offset c *Max*	Additional Diameter in Assymetrical $(d_w - d)$ *Max*	Weld $(G-d)$ *Max*	Additional Weld Diameter in Cylinderical Weld *Max*	Length e *Max*
14	2·45	2·8	4·9	4·9	8·4
18	3·16	3·6	6·3	6·3	10·8
22	3·85	4·4	7·7	7·7	13·2
24	4·20	4·8	8·4	8·4	14·4
26	4·55	5·2	9·1	9·1	15·6
30	5·25	6·0	10·5	10·5	18·0



CYLINDERICAL WELDED LINK



ASSYMETRICAL WELDED LINK

FIG. 10 DIMENSIONS FOR CYLINDERICAL WELDED AND ASSYMETRICAL WELDED CHAIN LINKS

d_n = Size (nominal diameter of the material);

d = Measured diameter of the material except at weld;

d_w = Measured diameter of the material at the weld (cylinderical welded chain) or weld dimension perpendicular to the plane of the link (assymetrical welded chain);

G — Dimension in other plane (assymetrical welded chain); and

e = Length affected by welding on either side of the centre of the link for all weld.

EXPLANATORY NOTE

Conveyor chains used in mines have to transmit large powers at low speeds and are subjected to frequent shock loads of high magnitudes. The chain is not expected to receive manual lubrication and it is not practical to incorporate automatic lubrication into the machine. Therefore, they have to be built very rugged.

The reliability of these chains is, therefore, an important factor and it is recommended that supplies of these chains should be obtained from manufacturers possessing adequate facilities for heat treatment and testing and employing competent staff for detailed inspection. Servicing these chains involves complex technical problems and should not be undertaken without consultation with the chain manufacturer.

This standard was initially published in 1967 and this revision has been undertaken with a view to incorporate the technical development brought out in the manufacture of these chains. The main additions incorporated in this revision include addition of a new Grade D of chain and deletion of Grade A and various tests, such as bend test and notch impact test.

Considerable assistance has been derived from ISO 610-1979 'High-tensile steel chains (round link) for chain conveyors and coal ploughs', issued by International Organization for Standardization (ISO).